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Cultural heritage assessment and vulnerability using Analytic Hierarchy Process and Geographic Information Systems (Valea Oii catchment, North-eastern Romania). An approach to historical maps

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ABSTRACT

The paper presents a method for determining the vulnerability of the landscape that can be applied to cultural heritage sites assessment, based on spatial data gathered from historical maps over a time span of 118 years (1894–2012) and integrated into GIS. Analytic Hierarchy Process (AHP) is employed in order to prioritise the natural and anthropogenic elements extracted from historical maps and orthophotos in order to produce the vulnerability maps and being able to assess and mitigate the effects on cultural heritage sites. In this case, the consistency ratio (CR) has a value of 0.06, which means that the pairwise comparison matrix has an acceptable consistency. The final vulnerability maps for Valea Oii catchment, North-eastern Romania, divided into four vulnerability classes (low, medium, high, and very high), will highlight the most vulnerable areas in terms of natural and anthropogenic elements and will be a powerful tool in the future development plans for the area.

1. Introduction

Vulnerability is a measure of the extent to which a community, structure, service or geographical area is likely to be damaged or disrupted, on account of its nature or location, by the impact of a particular disaster hazard [1]. We will refer in this paper to cultural heritage sites from a small catchment in North-eastern Romania. AHP is widely used in the decision-making process and is being applied in different fields of research belonging to geosciences, such as land suitability analysis [2,3], cultural heritage [4], landslide susceptibility [5,6], flood hazard [7], human settlements planning and development [8,9], soil erosion [10], because of its ability to successfully merge geographical data according to the importance given to the environmental factors (natural and anthropogenic). AHP represents one of the multiple criteria decision-making methods that was originally developed by Saaty in the 1970s [11], and is based on four stages: problem modelling, weights valuation, weights aggregation and sensitivity analysis. AHP has the advantage of allowing a hierarchical structure of the criteria, which grant users with a better core on specific criteria and sub-criteria when allocating the weights. Like any other method, AHP has its limitations [12]. The applications of the AHP are much broader and applied to a wide range of research and economic domains [13,14].

The elements taken into the analysis are structured into natural (gullies, landslides, and drainage network) and anthropogenic (road network, and rural sprawl), which have a good representation on the historical maps and orthophotos. Both globally and locally (north-eastern part of Romania) landslides [15,16] and gully erosion [17,18] are a real problem, affecting not only the human activities [19], cultural heritage as well [20–23]. As shown by [16], landslides and archaeological sites are closely related, prehistoric populations using the landslide depletion areas as defensive systems. Landslides are among the most frequent geomorphological processes in this area, which can be assigned to the category of very high potential, high probability, and average susceptibility to landslides [24]. The landslide susceptibility model of the catchment [22] highlights the fact that more than 65% of the Chalcolithic settlements are located in areas with high and very high susceptibility, raising the chances of degradation in the future.

Worldwide, fast gully head retreat is correlated to the runoff contributing area of the gully and the rainy days [17]; the fact that in

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